Master's Thesis Proposal

Development and characterization of cellulose nanocrystal (CNC) based inks for packaging applications.

An investigation of effects of different additives and processing conditions on optical properties of CNC-based solid films to develop sustainable inks for packaging.

The most spectacular colors in the natural world arise from photonic structures, such as the helicoidal arrangement of cellulose in the fruit of *Pollia condensata*. The investigation of such natural examples allows us to better understand how biological building blocks such as cellulose and chitin can be used to create more sustainable colorants.

Cellulose is a sugar-based polymer found in virtually all plants, making it one of the most abundant natural materials in the world. Cellulose can be extracted from natural sources in the form of thin rigid rods known as cellulose nanocrystals (CNCs). If CNCs are brought together at high enough concentrations, their collective behavior can produce photonic structures that can exhibit amazing colors under the right conditions. This spontaneous formation of a highly ordered structure from simple components is known as self-assembly.

The intense color of the CNC films arises from the helicoidal structure created by self-assembly. The twisting configuration of the CNCs forms a pattern that repeats over a certain distance, known as the pitch. This periodic structure reflects light at a certain wavelength corresponding to the pitch. If we change the pitch, the color of the film changes accordingly: a film with a larger pitch reflects longer-wavelength light, so the color is red-shifted, while a film with a smaller pitch reflects shorter-wavelength light, causing a blue-shift. Furthermore, by changing the conditions of the CNC self-assembly process, we can change the color of the films, and more generally control their visual appearance. We are working to develop a CNC-based ink with tailored physicochemical properties suitable for packaging use. To help us develop this, we are looking for a master's student with experience in materials science and/or chemistry. The project will involve the formulation, characterization, and product development of different types of CNC-based solid films.

The work will be supervised by Dr. Matteo Hirsch and Prof. Tiffany Abitbol and will take place at EPFL laboratories. Envisaged start date is September 2023 – 6 months. If you are interested, please, send the CV and a short motivation letter to matteo.hirsch@epfl.ch.